FIJI INSTITUTE OF TECHNOLOGY

SCHOOL OF ELECTRICAL & ELECTRONIC ENGINEERING

ADVANCED DIPLOMA IN ENGINEERING (ELECTRICAL & ELECTRONICS)

FINAL EXAMINATION

EEE607 – ELECTRONIC TECHNOLOGY (TELECOMMUNICATION)

Thursday 31st October, 2013 0900 - 1210 hours Venue: JNC

INSTRUCTIONS TO CANDIDATES:

1. Candidates are reminded that they should have no books, notes, paper or other material in their possession unless their use is specifically permitted by "Instructions to Candidates" set out below.
2. Reading time is of 10 minutes duration.
3. Examination time is of 3 hours duration.
4. Write your candidate number at the top of each attached sheet.
5. This paper consists of two (2) sections: A and B.
6. The total is out of 110 marks.
7. Attempt ALL questions in Section A and Section B.
8. Each question may carry a different mark.
9. A Formula & Facts sheet is attached.
10. A Table of Bessel Functions is on the page 10.
11. The 74LS153 datasheet is on page 11.
12. Non-Programmable Calculators may be used.

13. Cellphones are prohibited in the examination room.

Formula & Facts Sheet

1. $dB = 10\log_{10}\left(\frac{P_o}{P_i}\right)$
2. Entropy $H = \sum_{i=1}^{n} P_{xi} I_{xi} = \sum_{i=1}^{n} P_{xi} \log_2 \left(\frac{1}{P_{xi}}\right)$
3. $C = B\log_2\left(1+\frac{S}{N}\right)$ bps
4. $\frac{S}{N} = 10\log_{10}\left(\frac{S}{N}\right)$
5. ε_o = Permittivity of Free Space = $\frac{1}{36\pi}\times 10^{-9}\, F/m = 8.842\times 10^{-12}\, F/m$
6. μ_o = Permeability of Free Space = 4π x 10^{-7} H/m
7. c = Speed of Light = $\frac{1}{\sqrt{\mu_o \varepsilon_o}} = 3\times 10^8\, m/s$
8. $\underline{A}\times\underline{B} = (AB\sin\theta)a_n = \begin{vmatrix} a_X & a_Y & a_Z \\ A_X & A_Y & A_Z \\ B_X & B_Y & B_Z \end{vmatrix} = -B\times A$
9. $\nabla = \frac{\partial(\,)}{\partial x}\underline{i} + \frac{\partial(\,)}{\partial y}\underline{j} + \frac{\partial(\,)}{\partial z}\underline{k}$

   $\therefore \nabla\phi = \frac{\partial\phi}{\partial x}\underline{i} + \frac{\partial\phi}{\partial y}\underline{j} + \frac{\partial\phi}{\partial z}\underline{k}$
10. $h_{11}I_1 + h_{12}V_2 = V_1$

    $h_{21}I_1 + h_{22}V_2 = I_2$
11. $L = 2\times 10^{-7}\ln\left(\frac{D}{d}\right)$
12. $C = \frac{55.56\times 10^{-12}\varepsilon_r}{\ln\left(\frac{D}{d}\right)} = 102.1\, pF/m$
13. $Z_o = \frac{60}{\sqrt{\varepsilon_r}}\ln\left(\frac{D}{d}\right)$

$v = \frac{c}{\sqrt{\varepsilon_r}}\, m/s$

SECTION A **[10 Marks)**

No	Question	Answer
1.	Thermal noise and Shot noise are examples of	
2.	A gain of 6 dB by a 1mW signal results in	
3.	The name given by the Electronic Industries Association to the RS232 serial interface is	
4.	State the Nyquist formula for the Maximum Data Transfer rate.	
5.	The process of simultaneously transmitting two or more independent signals over a single communication channel or cable is referred to as	
6.	What is the reason for twisting of cables in the Twisted-pair ?	
7.	Name the condition that occurs when light travelling between 2 media reaches the 'critical angle'.	
8.	What is the rationale for the adoption of the Open System Interconnection 7-Layer model?	
9.	Convert –19 to 8-bit Two's Complement notation.	
10.	The mode that uses all the available bandwidth is called	

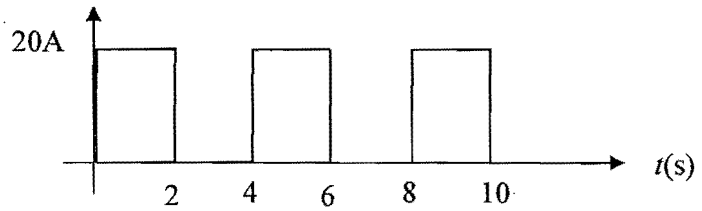
SECTION B **[100 Marks]**

Answer ALL questions.

QUESTION 1 **[MEDIA]**

(i) Analyze the current pulse train shown using the Fourier Series concept, to determine the amplitude and frequency of the fundamental and the first seven harmonics.

[8 marks]



(ii) Briefly explain the meaning of the term 'matched load'. **[2 marks]**

(iii) What will be the effect of open circuit termination on voltage and current?

[3 marks]

(iv) Figure 1 below shows an unshielded twisted pair cable of length 1 km connecting a 5 mV source and an output amplifier of gain 8 dB, terminating at the load, R_L. The cable has the following properties: $Z_0 = 100\ \Omega$, C = 60 pF/m, attenuation = 0.045 dB/m. Determine the output voltage, v_o.

[5 marks]

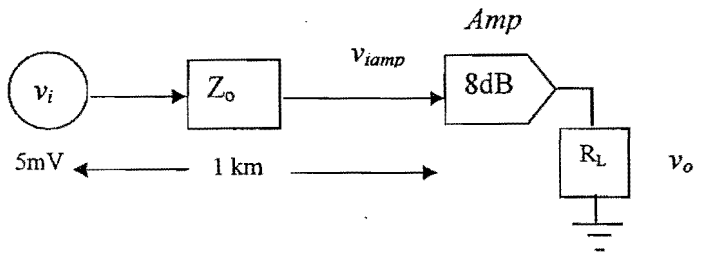


Figure 1

(v) List 2 advantages of Optical fibre over copper cable as a transmission medium.

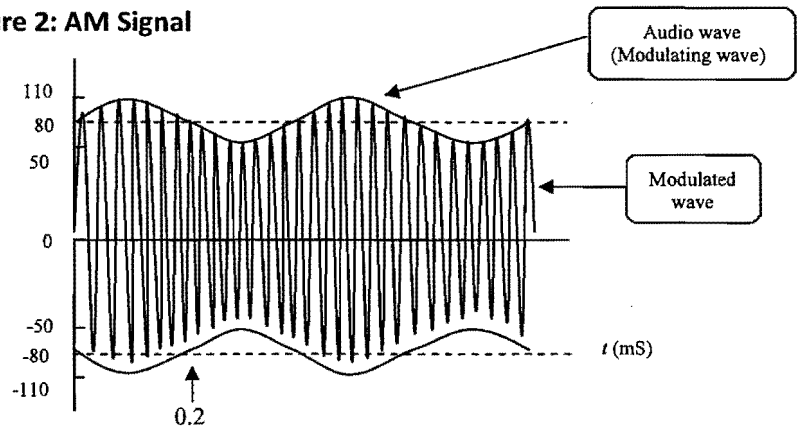
[2 marks]

[TOTAL = 20 MARKS]

QUESTION 2 [AMPLITUDE MODULATION]

(a) Consider the AM signal shown whose carrier angular frequency, ω_c, is $10^6\pi$ rad/s. The transmitted power is 2.8 kW.

Figure 2: AM Signal



(i) Derive the equation for the audio signal. **[2 marks]**

(ii) Find the equation of the carrier signal. **[2 marks]**

(iii) Determine the actual equation of the AM signal in Figure 3 given the general equation for the AM signal below.

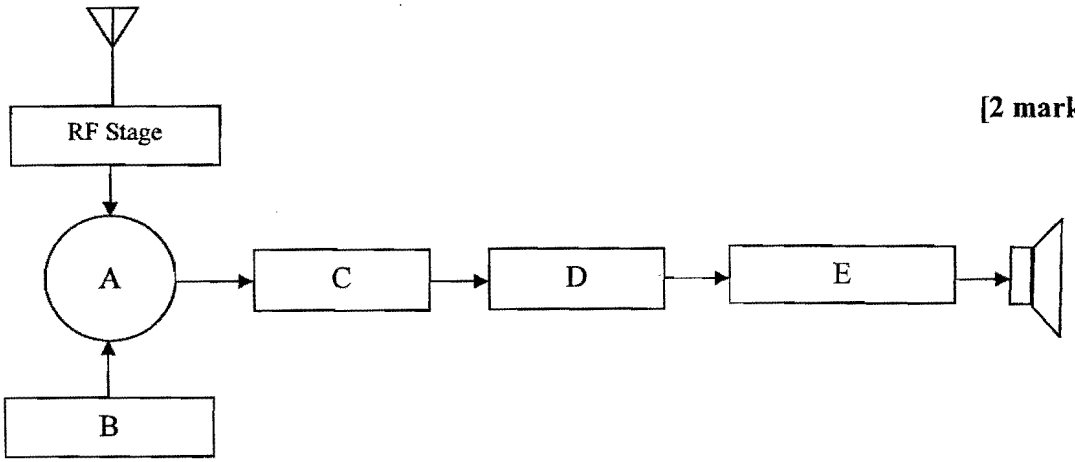
$$s(t) = E_c\left[1+\left(\frac{E_m}{E_c}\right)\cos(\omega_m t)\right]\cos(\omega_c t) = E_c\cos(\omega_c t)+\frac{mE_c}{2}\cos(\omega_c t+\omega_m t)+\frac{mE_c}{2}\cos(\omega_c t-\omega_m t)$$

[4 marks]

(iv) Analyse the system to find the power content of the carrier and each of the sidebands.

[5 marks]

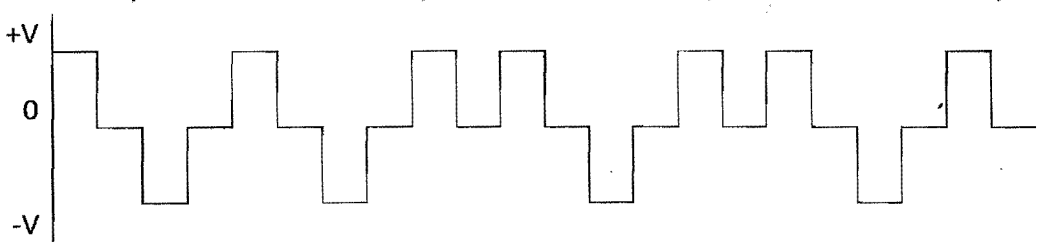
(b) Identify the unlabelled block of the typical radio receiver given.



[2 marks]

(b) The waveform shown is coded using Bipolar RZ. Determine the data that is being transmitted.

[5 marks]



[TOTAL = 20 MARKS]

QUESTION 3 [FREQUENCY MODULATION & PULSE CODE MODULATION]

(a) Consider an FM signal with a maximum deviation of 32 kHz, which is modulated with an audio frequency of 4 kHz. Resolve the required bandwidth using the Bessel Functions table. **[4 marks]**

(b) An FM signal is represented by $s(t) = 960\sin\left(8.4\times10^{8}t + 5\sin 2\pi\times4000t\right)$. Determine the following:

(i) Carrier frequency, f_c **[2 marks]**

(ii) Modulating frequency, f_m **[2 marks]**

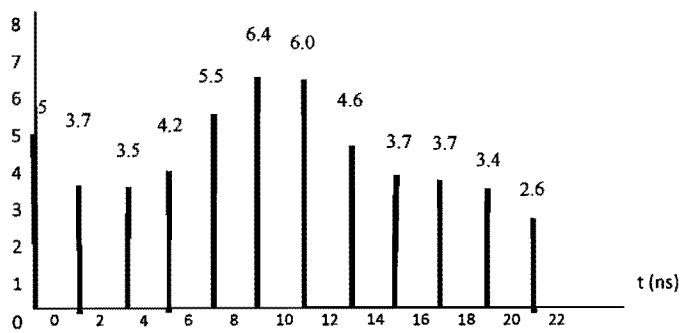
(iii) Modulation Index, m_f **[2 marks]**

(iv) Maximum frequency deviation, Δf_c **[2 marks]**

(v) The FM power transmitted if the antenna resistance is 8 Ω. **[3 marks]**

(c) An analogue signal is sampled every 2 ns over a 22 ns interval. The PAM pulses are shown. Sketch the quantized PCM pulses, and resolve for the final PCM output.

PAM Pulses



[5 marks]

[TOTAL = 20 MARKS]

QUESTION 4 [NOISE & INFORMATION THEORY]

(a) A communication equipment with a gain of 120 and a bandwidth of 2 MHz has an input resistance of 8 kΩ. It is operating at a temperature of 27 °C and receives an input audio signal of 6 uV_{rms}. Given Boltzmann's constant is 1.38 x 10^{-23} J/K, calculate the following

(i) White [Johnson] Noise Power **[3 marks]**

(ii) RMS input noise level **[3 marks]**

(iii) Audio output level **[2 marks]**

(iv) RMS output noise level **[2 marks]**

(b) The bandwidth, *B*, of the PSTN is 4 kHz while the S/N ratio is 50 dB. Determine the maximum information rate, *C*, predicted by Shannon's law, **[5 marks]**

$$C = B\log_2\left(1+\frac{S}{N}\right).$$

(c) A voice bank system has 5 possible messages with probabilities of 1/2, 1/4, 3/8, 1/32, and 13/32. Determine the Average Information Content per message, or Entropy.

[5 marks]

[TOTAL: 20 MARKS]

QUESTION 5 [ERROR CORRECTION & DETECTION; MULTIPLEXER]

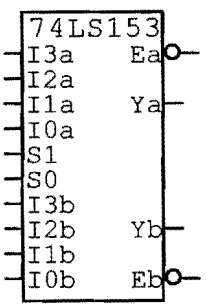
(a) The data, $M(x) = x^7 + x^6 + x^3 + x^0$, is transmitted over the PSTN while $P(x) = x^5 + x^3 + x^2 + x^1$ is the Check Pattern. The Cyclic Redundancy Check method is used to detect any error in transmission of data

(i) Derive the Frame Check Sequence (FCS) **[5 marks]**

(ii) What is the actual Transmitted Data? **[2 marks]**

(iii) Assume that the Received Data, R(x), is 1100 1011 11001. Is the transmission accurate? Explain how the CRC method checks for error in it **[3 marks]**

(b) Two mutually exclusive control circuits are described by the Boolean functions, $f_1(C,B,A) = \sum_m (0,1,4,5,6,7)$ and $f_2 = (C,B,A) = \sum_m (1,2,3,5)$. Realize the Boolean functions using the 74LS153 Dual 4-to-1 **Multiplexer** to implement the two functions where only one function is active at a time. Give explanations where appropriate. (Data sheet is given in the back).



[10 marks]

[TOTAL: 20 MARKS]

Table 1: BESSEL FUNCTIONS

x	n														
(m_f)	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}
0.00	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.25	0.98	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-
0.5	0.94	0.24	0.03	-	-	-	-	-	-	-	-	-	-	-	-
1.0	0.77	0.44	0.11	0.02	-	-	-	-	-	-	-	-	-	-	-
1.5	0.51	0.56	0.23	0.06	0.01	-	-	-	-	-	-	-	-	-	-
2.0	0.22	0.58	0.35	0.13	0.03	-	-	-	-	-	-	-	-	-	-
2.4	0.00	0.52	0.43	0.20	0.06	-	-	-	-	-	-	-	-	-	-
2.5	-0.05	0.50	0.45	0.22	0.07	0.02	-	-	-	-	-	-	-	-	-
3.0	-0.26	0.34	0.49	0.31	0.13	0.04	0.01	-	-	-	-	-	-	-	-
4.0	-0.40	-0.07	0.36	0.43	0.28	0.13	0.05	0.02	-	-	-	-	-	-	-
5.0	-0.18	-0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	-	-	-	-	-	-
5.5	0.00	-0.34	-0.12	0.26	0.40	0.32	0.19	0.09	0.03	0.01	-	-	-	-	-
6.0	0.15	-0.28	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	-	-	-	-	-
7.0	0.30	0.00	-0.30	-0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	-	-	-	-
8.0	0.17	0.23	-0.11	-0.29	-0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	-	-	-
8.65	0.00	0.27	0.06	-0.24	-0.23	0.03	0.26	0.34	0.28	0.18	0.10	0.05	0.02	-	-
9.0	-0.09	0.24	0.14	-0.18	-0.27	-0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03	0.01	-
10.0	-0.25	0.04	0.25	0.06	-0.22	-0.23	-0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.03	0.01

FAIRCHILD SEMICONDUCTOR™

August 1986
Revised March 2000

DM74LS153
Dual 1-of-4 Line Data Selectors/Multiplexers

General Description

Each of these data selectors/multiplexers contains inverters and drivers to supply fully complementary, on-chip, binary decoding data selection to the AND-OR-invert gates. Separate strobe inputs are provided for each of the two four-line sections.

Features

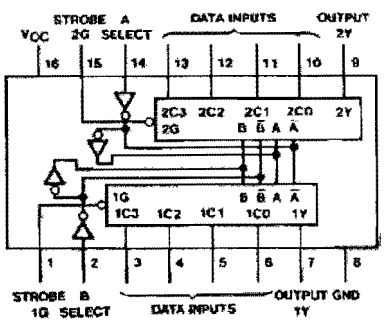
- Permits multiplexing from N lines to 1 line
- Performs at parallel-to-serial conversion
- Strobe (enable) line provided for cascading (N lines to n lines)
- High fan-out, low impedance, totem pole outputs
- Typical average propagation delay times
  - From data 14 ns
  - From strobe 19 ns
  - From select 22 ns
- Typical power dissipation 31 mW

Ordering Code:

Order Number	Package Number	Package Description
DM74LS153M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow
DM74LS153N	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Connection Diagram



Function Table

Select Inputs		Data Inputs				Strobe	Output
B	A	C0	C1	C2	C3	G	Y
X	X	X	X	X	X	H	L
L	L	L	X	X	X	L	L
L	L	H	X	X	X	L	H
L	H	X	L	X	X	L	L
L	H	X	H	X	X	L	H
H	L	X	X	L	X	L	L
H	L	X	X	H	X	L	H
H	H	X	X	X	L	L	L
H	H	X	X	X	H	L	H

Select inputs A and B are common to both sections.
H = HIGH Level
L = LOW Level
X = Don't Care

 DS006393